IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
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In re the Application of: Motofumi KASHIWAGI et al. Group Art Unit: 2879
Application No.10/524,117 Examiner: Christopher M. Raabe
Filed: February 10, 2005

For: LENS ARRAY SHEET

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The Honorable Commissioner of Patents and Trademarks
United States Patent and Trademark Office
Washington, D. C. 20231

DECLARATION UNDER 37 CFR 1.132

Sir:

I, Motofumi KASHIWAGI, declare and state that:

1. In March 1985, I was graduated from SAITAMA University, Faculty of Science and received a degree of Bachelor of Chemical from the same University.

Since 1988, I have been an employee of ZEON CORPORATION, and till the present time I have been engaged in research of electronic chemical and development of the application.

2. I am familiar with the invention described in the specification of the above-identified application.

3. I carried out the following experiment. Details of my experiment are as follows.

Experiment (comparative)

Two lens array sheets were prepared as following process. One lens array sheet (A) having a plurality of pyramid-shaped recesses on a surface of its transparent base material film, wherein a width "s" between adjacent recesses is 0% of a length "a" of one side of the bottom surface of the recess. And the other lens array sheet (B) having a plurality of pyramid-shaped recesses on a surface of its transparent base material film, wherein a width

"s" between adjacent recesses is 25% of a length "a" of one side of the bottom surface of the recess.

(Production of Substrates for lens array sheet (A) and (B))

After applying a positive type photoresist composition (product name: ZPP1700PG) made by ZEON Corporation by spin-coating on a substrate obtained by forming a film of SiO_2 to 300Å on a silicon, the result was prebaked at 100°C to obtain a resist film of 1.5 μm on the substrate.

The obtained resist film was subjected to exposure of 50 mJ/cm^2 by an exposure apparatus "PLA501F" made by Canon Inc. via a mask. Then, the width "s" between adjacent recesses is changed by changing of mask size.

And then, development processing was performed by a 2.38% tetramethyl ammonium hydroxide solution for 60 seconds, and then, rinse processing by ultrapure water was performed for 30 seconds. The substrate was dried by spin processing and prebaking processing at 120°C was finally performed to obtain a resist pattern on the substrate.

The thus obtained substrate was dipped in a hydrofluoric acid buffer solution (mixture of 3.6% hydrofluoric water and 18% hydrofluoric ammonium water by 1:1 (in volume) at 20°C. It will be the same below.) for five minutes to etch SiO_2, rinsing processing for immersing the etched substrate in pure water for 60 seconds was performed, then, the substrate was dried by spin processing.

The substrate, wherein the oxide silicon film was etched, was immersed in a 30% sodium hydroxide solution for 30 minutes at 80°C, immersed in pure water for 60 seconds, then, dried by blowing a dry air, so that pyramid-shaped concave recesses were formed on the silicon substrate.

To remove an excessive oxide silicon film remaining on the silicon substrate formed with the recesses, the substrate was dipped in a hydrofluoric acid buffer solution for 5 minutes, then, immersed in pure water for 60 seconds, and dried by blowing a dry air, so that a silicon substrate having pyramid-shaped recesses was produced.

(Production of Molds for lens array sheet (A) and (B))

After adhering the obtained silicon substrate on a fixture and forming a nickel film of about 500Å by vacuum evaporation on the surface, nickel metal was grown by performing electrolytic soldering in an electrolytic solution containing nickel sulfamate as its main component. The obtained nickel block (metal layer) was peeled from the silicon substrate, so

that a mold (convex mold) formed with pyramid-shaped "projections" in a hound's-tooth check shape was produced.

(Production of Lens Array Sheets (A) and (B))

This mold was set in an injection molding apparatus to obtain a lens array sheet (the outside dimension is 40 mm × 40 mm) having a thickness of about 1 mm by injection molding (resin melt temperature of 285°C, mold temperature of 130°C, and resin filling time of about 0.2 second) using a cycloolefin polymer (ZNR1430R made by ZEON Corporation).

The obtained lens array sheet (A) and (B) were formed on their surface with pyramid-shaped "recesses" having a bottom surface of 20 μm × 20 μm, a base angle of side surfaces of approximately 60° and a height of 14 μm in a hound's-tooth check shape.

(Evaluation of lens array sheet (A) and (B))

Measurement of scratch-resistant was made on the obtained lens array sheet (A) and (B) by following process.

At first, a measurement device (hardness meter) was prepared (See Figure 1 below). A sapphire needle was fitted with the device (See Figure 2 below). The spherical diameter of the needle point was 2 mm.

The lens array sheet (A) and (B) were scratched by the needle with load changing. The result is shown in Figure 3. From Figure 3, the lens array sheet (B) was more scratch-resistant than the lens array sheet (A).

Fig. 1

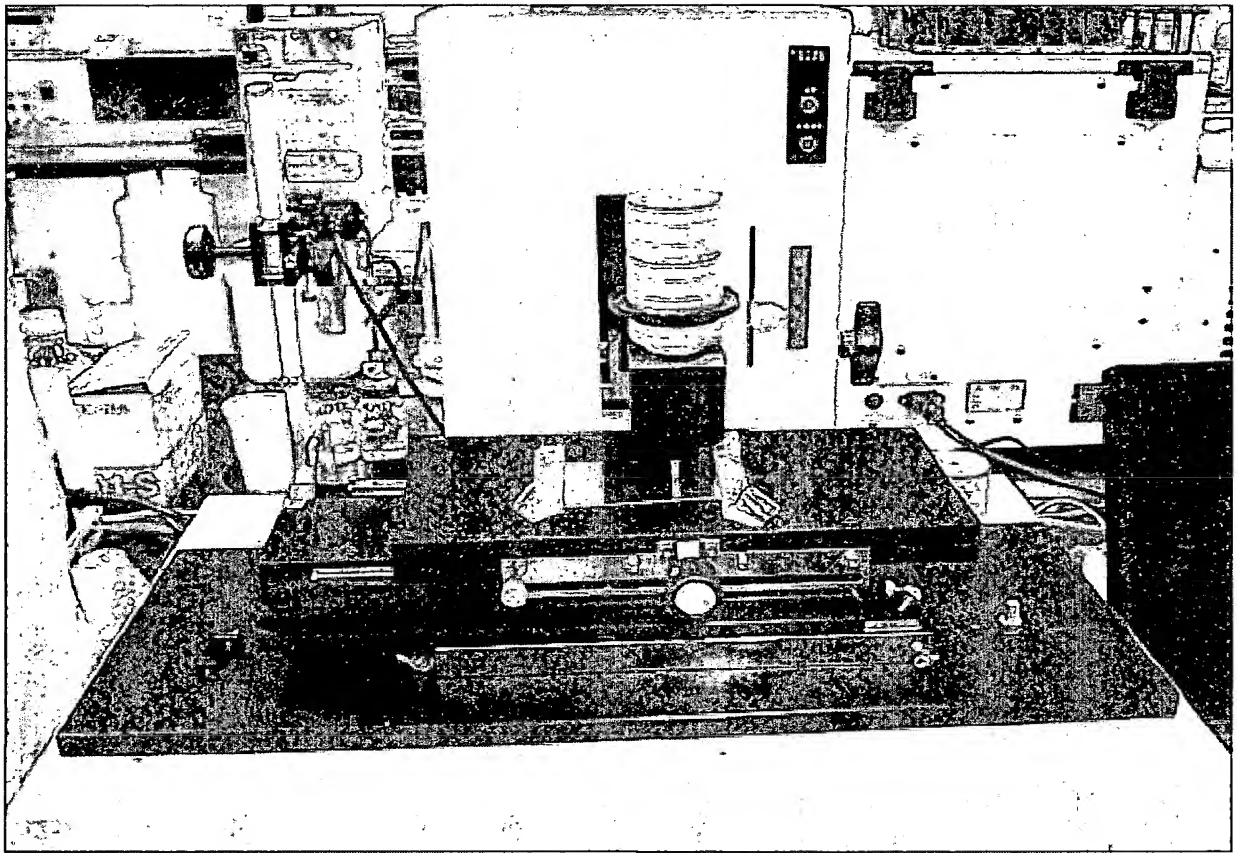


Fig. 2

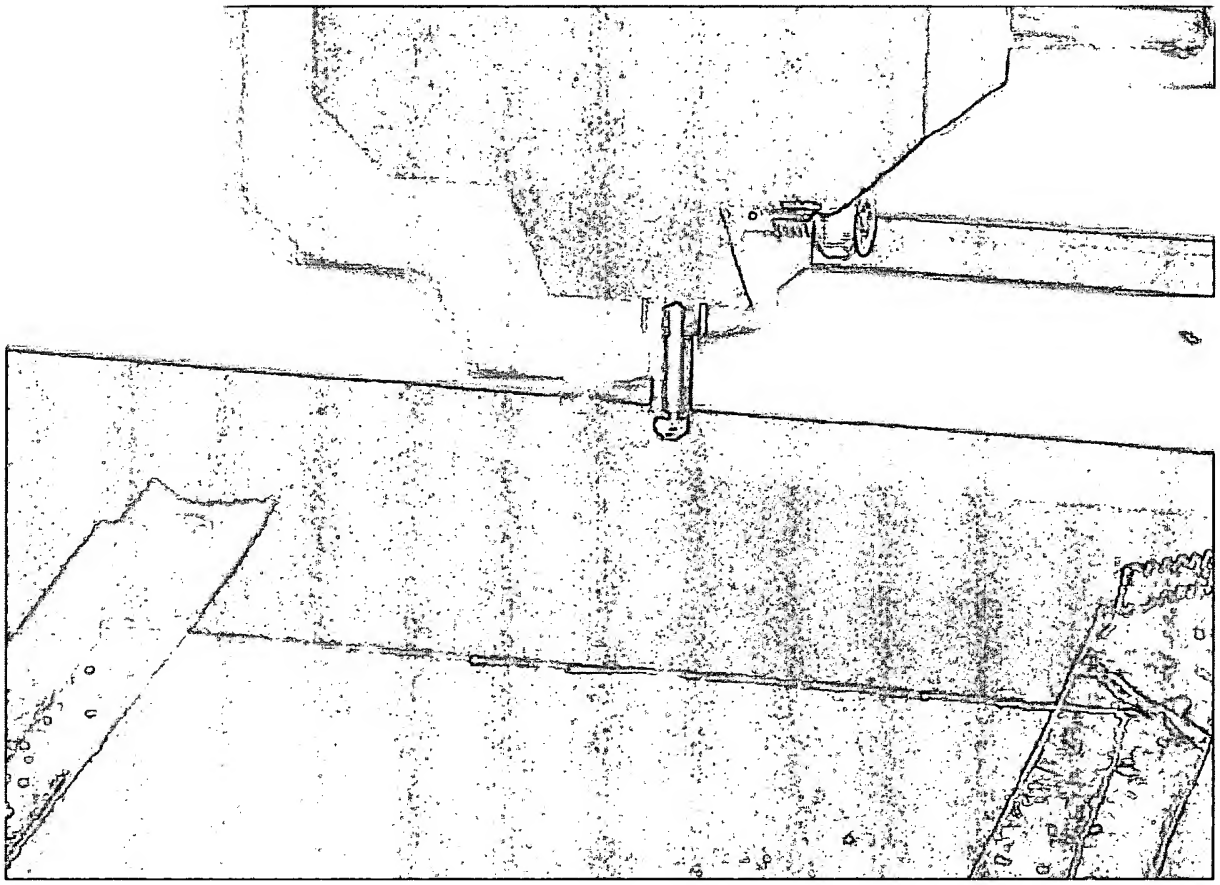
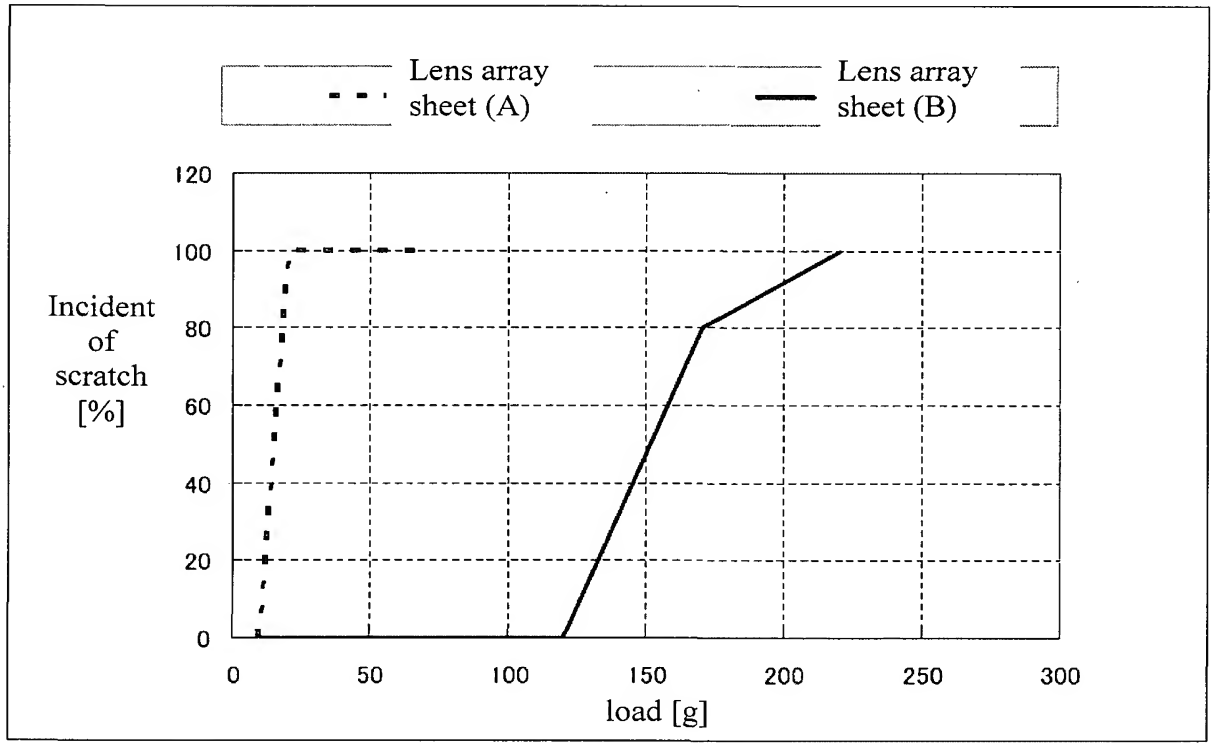


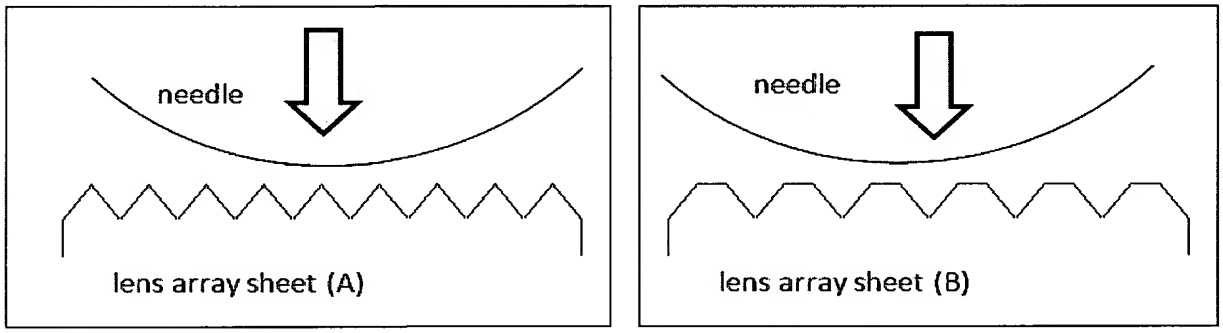
Fig. 3


Lens array sheet (A)
Lens array sheet (B)
Incident of scratch [%]
120
100
80
60
40
20
0
0
50
100
150
200
250
300
load [g]

From the results of the above experiment, and based on my knowledge and experience on Polymer Chemistry, I conclude that:

By comprising the constituent "a width "s" between adjacent recesses is more than 0% and not more than 50% of a length "a" of one side of the bottom surface of the recess" as the lens array sheet (B), the lens array sheet is more scratch-resistant. This is because the exterior flat space of lens array sheet (B) is larger than that of lens array sheet (A) (See Figure 4 below. Figure 4 is cross-section drawing of lens array sheet (A) and (B)). Therefore the pressure of the lens array sheet (B) is lower than that of the lens array sheet (A). For this reason the lens array sheet (B) is more scratch-resistant than lens array sheet (A).

Fig. 4



The undersigned declares further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

This 7 day of December 2009

Motofumi Kashiwagi

Motofumi KASHIWAGI